

Joint Wisconsin Senate/Assembly Hearing on Groundwater Protection
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Approaches to Groundwater Management in Wisconsin

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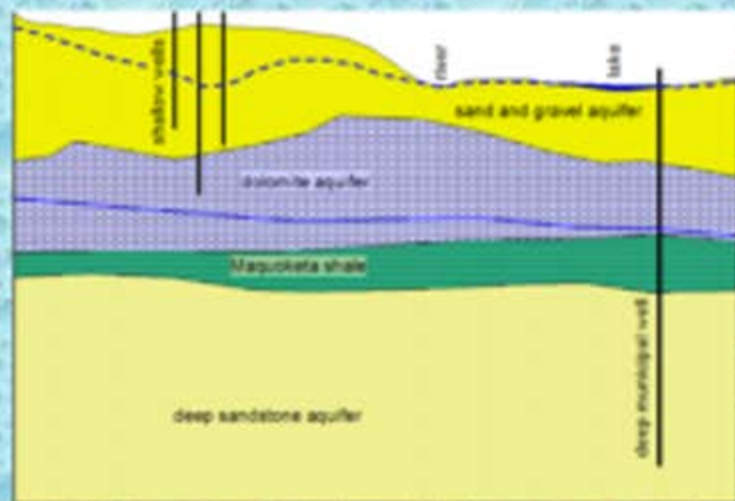
Today's objectives

- Technical resources and suggested approaches for groundwater management
 - Water budgets
 - Groundwater flow models
 - Data availability
- Criteria for Groundwater Management Areas (GMAs) and Groundwater Attention Areas (GAAs)

Key concepts

- Groundwater and surface water are connected, and comprise a *single resource*
- Confined and unconfined aquifers behave differently. Drawdown is a *poor indicator* of stress for unconfined aquifers
- All water comes from somewhere – understanding the *water balance* is critical for management decisions

Typical
hydrogeology
in SE
Wisconsin

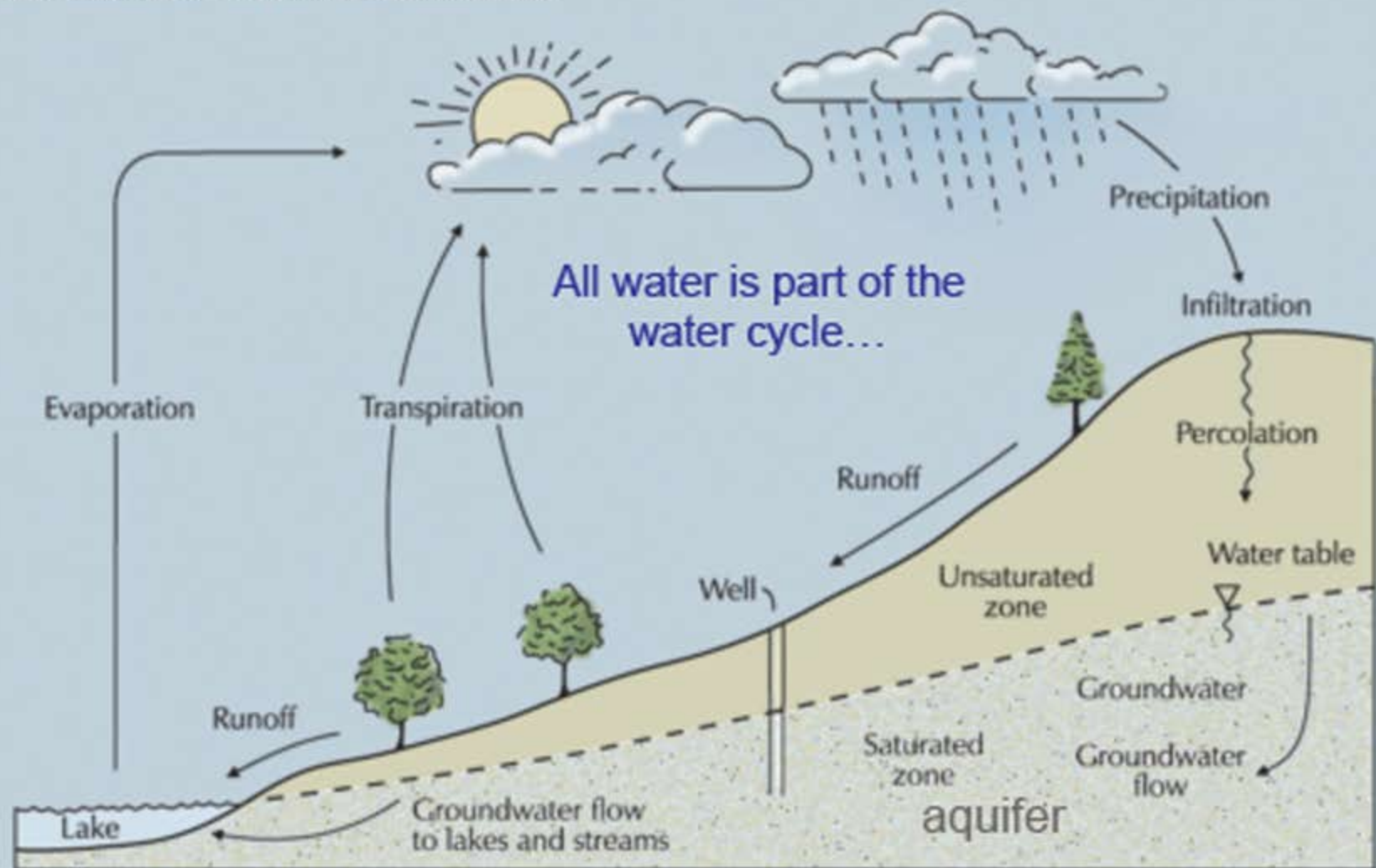


unconfined aquifer

confining unit (aquitard)

confined aquifer

The *water balance* is the relationship between replenishment and discharge. Healthy environmental systems require the water balance to be maintained.

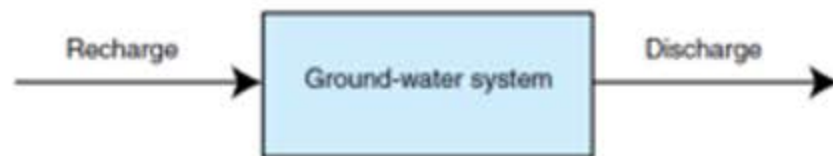


Water budget basics

- Like a bank balance, a water budget includes *all* inflows and outflows of water
- Models inherently provide this water budget accounting
- In Wisconsin, the most obvious evidence of “deficit” in the water budget is decreased baseflow to streams, springs, lakes, and wetlands

Unstressed and stressed groundwater budgets

A



B

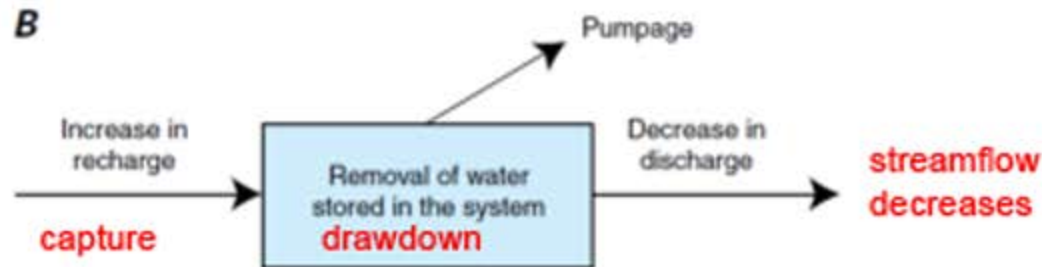


Figure 8. Diagrams illustrating water budgets for a ground-water system for predevelopment and development conditions.

(A) Predevelopment water-budget diagram illustrating that inflow equals outflow. (B) Water-budget diagram showing changes in flow for a ground-water system being pumped. The sources of water for the pumpage are changes in recharge, discharge, and the amount of water stored. The initial predevelopment values do not directly enter the budget calculation.

Water Use Indices

(Cherkauer, 2009; Weiskel and others, 2007)

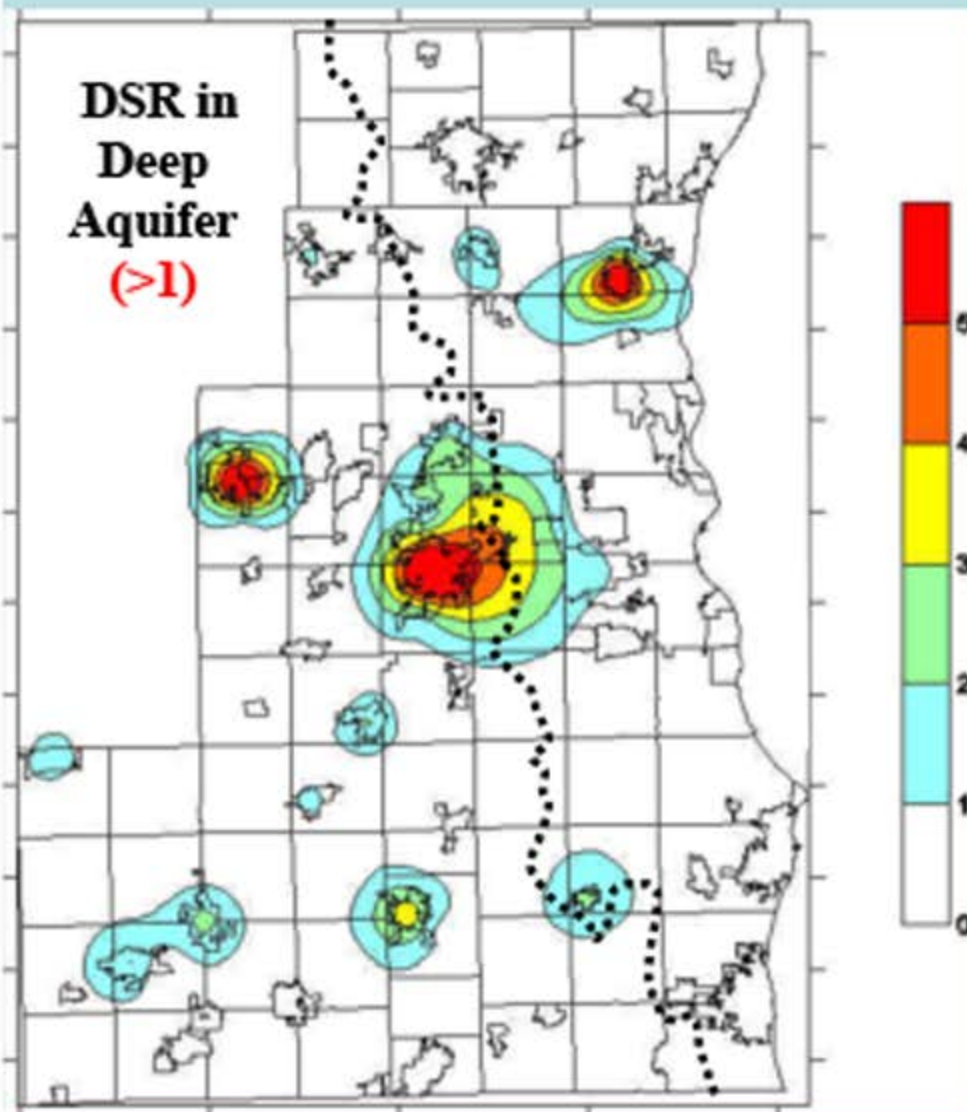
Once we develop a groundwater budget, we can calculate *indicator ratios* designed to answer such questions as:

1. How does the quantity of water being removed by wells relate to an aquifer's natural supply?
2. How much have humans altered the groundwater system?
3. What effect does this human alteration have on surface waters?

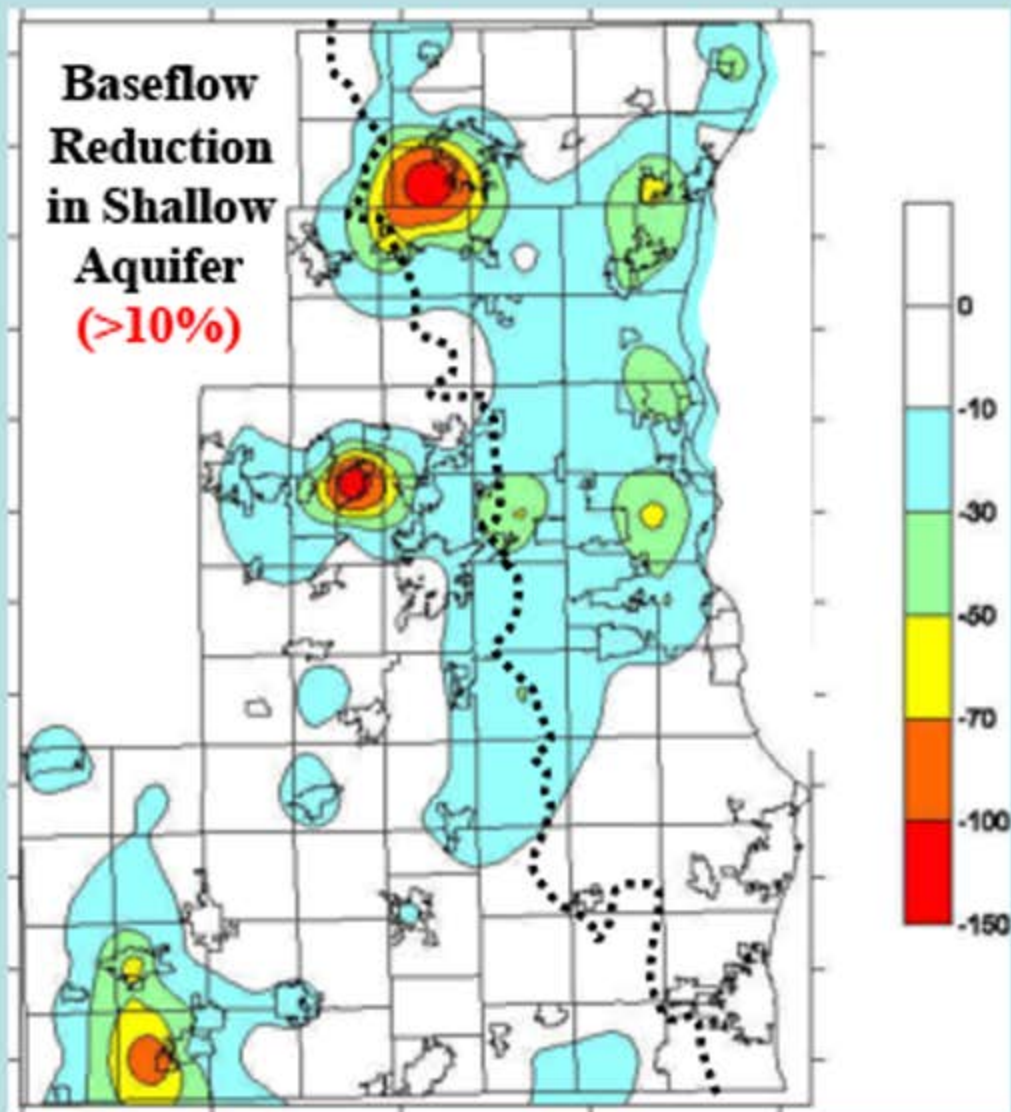
Prof. D. Cherkauer (UW-MKE) has developed indices for the SEWRPC region (next slide)

Example of water use indices: SEWRPC Demand to Supply Ratio

**DSR in
Deep
Aquifer
(>1)**



**Baseflow
Reduction
in Shallow
Aquifer
(>10%)**



**Region has considerable reduction –
primarily in headwaters**

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Source: Cherkauer, 2009

Use of flow models in groundwater management

- Models are the *current standard of professional practice* in hydrogeology
- based on mathematical and physical principles; give objective solutions
- Integrate impacts from multiple stresses (wells)
- Produce a complete water balance
- Contain a database of hydrogeologic information

“Hydrologists are occupied in studying aquifer dynamics. The principal tool for these investigations is the ground water model.” John Bredehoeft, 2002

Areas currently covered by groundwater flow models

County scale

Basin or multi-county scale

Local scale (municipalities)

Special projects



USGS Lake Michigan Basin model

(covers eastern
half of
Wisconsin)

Hydraulic conductivity distribution